Identification of High Temperature Pyrolysed Carbon Phenolic Composite Conductivity

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During atmospheric re-entry, hypersonic vehicles are submitted to very high dynamic heat flux. Heatshield re-entry bodies can be made of ablative materials like carbon phenolic composites. To obtain the heatshield assessment, it is necessary to know the thermal properties of the pyrolysed carbon phenolic material, like high temperature conductivity. During re-entry, the fast variation of phenomena, particularly the heat flux evolution, produces both a high non-linear behaviour inside the material and a heating rate of a few hundred degrees per second. This led us to develop a xenon arc lamp furnace in order to obtain high thermal fluxes (8 MW/m²) and therefore a dynamic heating in material samples (500°C/s near the heated surface). During the test, the applied heat flux evolution and the temperature, measured by means of thermocouples, which are placed at different depths in the material, are known. The different temperature measurements allow us to estimate the material thermal properties. The thermal conductivity can be identified, as a function of temperature, by solving the associated one dimensional inverse heat conduction problem. First, thermal tests are performed with three carbon fabric orientations materials of 0, 20, and 90 degrees in relation with the sample surface. Then, the heat capacity being supposed to be known, the conductivity versus temperature is identified with the least square technique up to 2000K. The conductivity is a function of the carbon fabric orientation and it increases with temperature, following the example of the vitreous carbon material. Finally, the results are compared successfully to those obtained with a standard method which is a modulate one. To validate this identification strategy, our approach is limited here to pyrolysed carbon phenolic composites, without phase transformation.